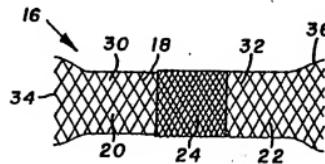




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : A61F 2/06		(11) International Publication Number: WO 92/00043
		A1
		(43) International Publication Date: 9 January 1992 (09.01.92)
<p>(21) International Application Number: PCT/US91/02854</p> <p>(22) International Filing Date: 25 April 1991 (25.04.91)</p> <p>(30) Priority data: 544,923 28 June 1990 (28.06.90) US</p> <p>(71) Applicant: SCHNEIDER (USA) INC. [US/US]; 5905 Nathan Lane, Plymouth, MN 55442 (US).</p> <p>(72) Inventor: PORTER, Christopher, H. ; 19756 N.E. 127th Place, Woodinville, WA 98072 (US).</p> <p>(74) Agents: RICHARDSON, Peter, C. et al.; Pfizer Inc., Patent Department, 235 East 42nd Street, New York, NY 10017 (US).</p>		<p>(81) Designated States: AT (European patent), BE (European patent), CA, CH (European patent), DE (Utility model), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).</p> <p>Published With international search report.</p>
BEST AVAILABLE COPY		

(54) Title: SELF-EXPANDING PROSTHESIS HAVING STABLE AXIAL LENGTH



(57) Abstract

A body implantable stent (16) consists of two or more generally tubular, coaxial and slidably connected stent segments (20, 22). Each segment (20, 22) is of open weave construction, formed of multiple braided, helically wound strands of resilient material. The stent is elastically deformed to a reduced radius when deployed. When released after positioning, the stent (16) self-expands radially and each segment (20, 22) contracts in the axial direction. To preserve a consistent length of the stent (16) the axially outward and non-overlapping portions (30, 32) of the stent (16) can be designed for secure fixation to the tissue, for example as radially outward flares (34, 36). Alternative approaches to maintain axial length include the addition of reinforcing filaments (62) near the stent opposite ends to increase the restoring force, the provision of fixation hooks (70) at opposite ends of the stent, and securing an elongate, axially directed, flexible and inextensible wire (104) to the opposite ends of the stent.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	ES	Spain	MG	Madagascar
AU	Australia	FI	Finland	ML	Malta
BB	Barbados	FR	France	MN	Mongolia
BE	Belgium	GA	Gabon	MR	Mauritania
BF	Burkina Faso	GB	United Kingdom	MW	Malawi
BG	Bulgaria	GN	Guinea	NL	Netherlands
BJ	Benin	GR	Greece	NO	Norway
BR	Brazil	HU	Hungary	PL	Poland
CA	Canada	IT	Italy	RO	Romania
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland	KR	Republic of Korea	SN	Senegal
CI	Côte d'Ivoire	LI	Liechtenstein	SU	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	US	United States of America
DK	Denmark				

- 1 -

SELF-EXPANDING PROSTHESIS HAVING STABLE AXIAL LENGTH

Technical Field

The present invention relates to body implantable devices, and more particularly to 5 prostheses and grafts intended for long-term or permanent fixation in body cavities.

Background Art

A wide variety of patient treatment and diagnostic procedures involve the use of devices 10 inserted into the body of the patient, with some of these devices being permanently implanted. Among these devices are prostheses or grafts for transluminal implantation, for example as disclosed in U. S. Patent No. 4,655,771 (Wallsten). The 15 prosthesis described in Wallsten is a flexible tubular braided structure formed of helically wound thread elements. Gripping members at opposite ends of the prosthesis initially secure it to a catheter, with the proximal gripping member being movable 20 distally to give the prosthesis the shape of a balloon. In deployment, the gripping members and catheter are removed, leaving the prosthesis to assume a substantially cylindrical shape as it slightly expands and substantially conforms to a 25 blood vessel wall or other tissue. Another prosthesis is disclosed in U. S. Patent No. 4,681,110 (Wiktor). A flexible tubular liner, constructed of braided strands of a flexible plastic, is insertable 30 into the aorta, whereupon it self-expands against an aneurysm to direct blood flow past the aneurysm. The braided stents of Wallsten and Wiktor axially contract as they radially expand.

Another elastic stent is shown in U. S. Patent No. 4,830,003 (Wolff et al). The stent includes a

- 2 -

series of generally longitudinal wires welded together in pairs, with the wires in each pair then bent into a "V" shape. Like the braided stents, this stent shortens axially as it radially expands.

5 Prostheses also have been constructed of plastically deformable materials. U. S. Patent No. 4,733,665 (Palmaz) discloses intraluminal vascular grafts radially expanded using angioplasty balloons. The grafts are wire mesh tubes, and axially shorten
10 as they radially expand. U. S. Patent No. 4,800,882 (Gianturco) features a stent formed of wire, including a plurality of serpentine bends to form opposed loops. A balloon is inflated to radially expand the stent, without substantial axial
15 shortening.

Yet another approach to prosthesis design is shown in U. S. Patent No. 3,868,956 (Alfidi et al). Alfidi et al discloses a strainer or screen with a plurality of generally longitudinal wires, bound
20 together by a cylindrical sleeve. The wires are deformable into a longitudinal, straight-line configuration for implantation. Once implanted, the device is heated. Due to the recovery property of the metal forming the wires (e.g. nitinol alloy),
25 heating causes the wires to flare radially outward at the opposite ends, thus to secure the device at the desired location. A stent including means for maintaining a constant axial length in spite of radial expansion or contraction, is disclosed in U.
30 S. Patent No. 4,553,545 (Maass et al), as a prosthesis in the form of a helical coil spring. In one embodiment, a constant axial length of the spring is maintained, with opposite ends of the spring rotated relative to one another to change the spring.

- 3 -

pitch and radius. An alternative approach involves maintaining a constant pitch over a given section of a spring, by providing spring material to a "constant length" section from a more compressed section of the 5 spring. In each case, the spring preferably is elastic, with a memory favoring the radially expanded configuration.

A self-expanding stent or prosthesis often is preferred over a plastically deformed device.

10 Resilient stents can be deployed without dilatation balloons or other stent expanding means. A self-expanding stent can be preselected in accordance with the diameter of the blood vessel or other fixation site. While deployment requires skill in 15 positioning the prosthesis, the added skill of properly dilating the balloon to plastically expand a prosthesis to a selected diameter is not required. Also, the self-expanding device remains at least slightly compressed after fixation, and thus has a 20 restoring force which facilitates acute fixation. By contrast, the plastically expanded stent must rely on the restoring force of deformed tissue, or on hooks, barbs or other independent fixation means.

Further advantages arise from constructing the 25 prosthesis of multiple, braided and helically wound strands or filaments as in the aforementioned Wallsten patent. The filaments themselves have a restoring force which causes the filaments to bear against tissue walls of the body cavity in which the 30 stent is fixed, thus maintaining the cavity open. At the same time there is sufficient space between adjacent filaments to promote embedding of the stent into the tissue, and fibrotic growth to enhance long-term fixation. A further advantage of this

- 4 -

construction is that it enables a substantial radial contraction of the prosthesis during deployment, for example to as little as about one-fourth of the normal diameter (the diameter in the relaxed state, 5 i.e. when subject to no external forces). This facilitates deployment of the prosthesis through narrow vessels or other constrictions on the way to the point of fixation.

At the same time, a substantial axial elongation 10 accompanies the radial contraction. There is a substantial axial contraction or shortening as the stent self expands, once free of its radial constraint. Thus, there is a rubbing or scraping action axially along tissue as the radially expanding 15 stent also axially shortens. Should tissue at the fixation area further yield to radial prosthesis expansion in the longer term, such expansion causes further axial shortening and wiping action, and presents further risk of injury to tissue. A further 20 drawback is that a stent during its fixation may radially expand more than expected, retaining less than the intended or minimum necessary axial length. Likewise, a plastically deformable stent may require more than the anticipated radial expansion and axial 25 shortening.

Therefore, it is an object of the present invention to provide a prosthesis of open weave, helical and braided construction capable of substantially maintaining its axial length as it 30 radially self-expands.

Another object is to provide a radially expanding tubular stent comprised of at least two stent segments, with an area of overlap of the sections variable in axial length to maintain a

- 5 -

consistent axial separation between non-overlapping ends of the stent.

Yet another object is to provide a stent with a medial portion variable in axial length, in combination with means at the opposite end portions of the stent for fixing the stent to bodily tissue, such that the bodily tissue maintains a substantially constant axial separation of the two end portions during any radial expansion or contraction of the stent.

Disclosure of Invention

To achieve these and other objects, there is provided a body implantable device, including coaxial first and second open weave stent segments slidably engaged to form a stent. The stent segments are engaged along respective concentric first and second axially inward portions overlapping one another to form a medial region of the stent. Further, the stent segments include opposite non-overlapping first and second axially outward regions with respective and opposite first and second ends of the stent. The stent segments, at least along the axially inward portions, have a predetermined first diameter and a predetermined first axial length. The stent segments are radially compressible to a second diameter less than the first diameter and to a second axial length longer than the first axial length, to facilitate an axial insertion of the stent into a body cavity for delivery to a selected location along the body cavity and subsequent fixation of the stent to a cavity wall segment defining the body cavity. During its fixation, the stent radially expands. The first and second axially inward portions slide relative to one another to reduce the axial length of the medial

- 6 -

region during the radial expansion. Thus the stent maintains a substantially constant axial length during radial expansion.

A preferred approach uses means for fixing the 5 outward ends of a self-expanding stent, e.g. respective first and second flared outer end portions along the axially outward regions of the stent. The first and second ends have diameters greater than the first diameter when the stent is in the relaxed 10 state, and when compressed tend to have a greater restoring force against the cavity wall segment, as compared to the remainder of the stent. The end diameters should be greater than the medial region diameter by five percent or more, ensuring a 15 substantial difference in restoring force for a relatively constant diameter of the cavity along the tissue wall segment.

Alternatively, the outer end portion of each 20 stent segment can have the same diameter as the medial region, but be composed of larger diameter filaments, added windings of filaments or otherwise have increased stiffness or resistance to radial contraction as compared to the medial region. Yet another alternative is to provide fixation elements, 25 for example hooks, at the opposite ends of the stent.

In combination with positive fixation of the 30 stent ends, a substantial medial overlapping region is provided when the stent segments are in a radially compressed or delivery configuration. For example, the overlapping region may comprise three-fourths or more of the axial length of the compressed stent. Then, upon deployment of the stent, both stent segments radially expand and axially shorten. With the outer ends of the stent fixed, the axial

- 7 -

shortening occurs only along the medial region, substantially shortening the region of overlap but maintaining the desired axial separation of the opposite stent ends.

- 5 An open weave of braided, helically wound strands or filaments is the preferred structure of the tubular stent. The open weave structure enables substantial self-expansion in the stent, for example to a fixation diameter at least three times the
- 10 diameter during delivery. This of course results in a substantial corresponding axial shortening in each of the stent segments, but due to the overlapping medial region of the stent, the overall axial length remains virtually constant.
- 15 A pliable catheter is a suitable apparatus for delivery and deployment of the stent. More particularly, a pliable sheath can surround at least the distal end portion of the catheter and extend beyond the distal tip to surround the stent segments
- 20 as well, maintaining them in a radially compressed delivery configuration. The catheter can be provided with a lumen, through which a guide wire may be inserted to facilitate travel of the catheter and compressed stent through blood vessels or other body
- 25 cavities to the fixation area. Once the catheter is inserted properly to position the stent at the desired fixation point, the outer sheath is withdrawn proximally, with the stent abutting the catheter and thus secured against proximal travel with the sheath.
- 30 The distal portion of the stent self-expands first, and in expanding against tissue, secures the stent segment against proximal travel. With one end of the stent constrained by tissue and the opposite end constrained by a stationary catheter, the axial

- 8 -

length of the stent remains substantially constant. Axial shortening of the stent segments, which accompanies their radial expansion, tends to diminish the length of the medial region and leave the overall 5 axial length unaffected.

Following fixation, further yielding of the tissue segment can result in further radial expansion of the stent. However, with the opposite ends of the stent secure, any axial shortening of the stent 10 segments again affects only the medial overlapping region. Thus, the advantages of the open weave construction are retained, without an undesirable shortening of the stent as it radially self-expands.

Brief Description of Drawings
15 For a further understanding of the above and other features and advantages, reference is made to the following detailed description and the drawings, in which:

Figure 1 is a side elevation of a body 20 implantable device constructed in accordance with the present invention;

Figure 2 is a side sectional view of a catheter and sheath retaining the implantable device in a radially compressed condition;

25 Figure 3 is an end view of the device, catheter and sheath;

Figure 4 is a side sectional view showing deployment of the device within a body cavity;

Figure 5 is a side view of the device fixated 30 within the cavity;

Figure 6 is a side elevation of an alternative embodiment device in the relaxed or fully radially expanded condition;

- 9 -

Figure 7 is a side elevation showing yet another alternative device in the expanded or relaxed condition;

5 Figure 8 is a side elevation illustrating a further alternative device in a radially compressed state;

Figure 9 is a side elevation of the device of Figure 8 in the expanded condition;

10 Figure 10 is a side elevation showing yet another alternative device, in a radially compressed condition; and

Figure 11 is a side elevation of the device of Figure 10 in the radially expanded condition.

Modes for Carrying Out the Invention

15 Turning now to the drawings, there is shown in Figure 1 a body implantable prosthesis or stent 16. Stent 16 has an open mesh or weave construction, formed of helically wound and braided strands or filaments 18 of a resilient material, for example a 20 body compatible stainless steel or an elastomer, e.g. polypropylene, polyurethane, polysulfone or a polyester.

Stent 16 includes coaxial proximal and distal stent segments 20 and 22. A medial region 24 is 25 formed by the overlapping of respective axially inward portions of stent segments 20 and 22. Axially outward, non-overlapping portions of the stent segments are indicated at 30 and 32, respectively. At opposite ends of the stent are flared ends 34 and 30 36, each having a greater radius than the nominal radius over the majority of the stent length. As is later explained, flared ends 34 and 36 provide a fixation feature useful to maintain a constant overall axial length in stent 16, even while stent

- 10 -

segments 20 and 22 radially self-expand and axially contract during fixation.

In Figure 1, stent 16 is shown in its relaxed condition, with no external forces applied to

5 radially contract the stent. Stent 16 is self-expanding in the sense that when not subject to external forces, it assumes a diameter much larger than the diameter illustrated in Figures 2 and 3. In these figures, the stent is elastically deformed and 10 maintained in a radially reduced configuration by a pliable, dielectric sheath 38 surrounding the stent.

An elongate and pliable catheter 40, of which just the distal end region is shown in Figure 2, includes a distal tip 42 which abuts the proximal end 15 of the stent. The proximal portion of sheath 38 surrounds the distal end region of the catheter. Catheter 40 has a central lumen 44 open to tip 42 and running the length of the catheter, to permit delivery of a drug, in liquid form, to the catheter. 20 distal tip from a supply at the proximal end of the catheter. Lumen 44 further enables the use of a guide wire (not shown) which can be intravenously inserted, by its distal end to the desired point of fixation for stent 16. With the guide wire in place, 25 catheter 40, stent 16 and sheath 38 are positioned to surround the proximal end of the guide wire with the guide wire contained within lumen 44. Then, the catheter, sheath and stent are moved distally or advanced, directed by the guide wire to the fixation 30 location, whereupon the guide wire can be withdrawn.

Sheath 38 preferably is constructed of silicone rubber or other suitable biocompatible material, and surrounds the stent and catheter at least along the catheter distal end region, or along the full length

- 11 -

of the catheter if desired. Sheath 38 preferably is thin to facilitate intravascular insertion of the catheter, sheath and stent, yet is sufficiently thick to maintain stent 16 in a reduced radius or delivery 5 configuration against the restoring force of strands 18. The outside diameter of the assembly including the catheter, stent and sheath is approximately 2.3 millimeters.

Stent 16 is particularly well suited for use as 10 a prosthesis or graft in a blood vessel or other body cavity. One advantageous use of the stent occurs in connection with percutaneous transluminal coronary angioplasty (PTCA) procedures. While such procedures afford significantly reduced cost and risk as 15 compared to coronary bypass operations, acute closure and recurrence of stenosis are significant problems in up to about thirty percent of constricted or blocked passages opened by balloon angioplasty. The fixation of stent 16 within a blood vessel along a 20 previously occluded region tends to keep this region permanently open.

Fixation of stent 16, within a blood vessel 46 having a tissue wall segment 48, begins with 25 intravascular insertion of the stent, catheter and sheath in the delivery configuration shown in Figures 2 and 3. The reduced radius facilitates insertion of this assembly through blood vessel 46 until stent 16 reaches a predetermined fixation location along the blood vessel. Once the proper positioning of the 30 stent is confirmed, e.g. through use of one or more radiopaque markings on the stent, sheath or catheter, sheath 38 is moved proximally with respect to catheter 40.

- 12 -

With distal tip 42 abutting stent 16, the catheter prevents the stent from traveling proximally with sheath 38 as the sheath is withdrawn. Thus, as seen from Figure 4, stent 16 becomes free of sheath 38 over an increasing distal portion of its axial length. As each of stent segments 20 and 22 becomes free, it radially self-expands until contacting tissue wall segment 48, then undergoes slightly further radial expansion until the tendency to 10 radially expand is counterbalanced by the restoring force exerted radially inward by the tissue wall segment. At the equilibrium condition, shown in Figure 5, stent is not fully radially expanded to the relaxed configuration shown in Figure 1, and thus 15 applies a restoring force which tends to maintain the stent at the fixation position within vessel 46.

A salient feature of the present invention is the concentric and slidable mounting of stent segments 20 and 22 in combination with the fixation 20 provided by flared ends 34 and 36. During initial withdrawal of sheath 38, the distal flared end 36 is the first to encounter tissue wall segment 48. Due to its larger nominal (relaxed state) diameter, flared end 36 tends to radially expand somewhat more 25 than the remainder of axially outward portion 32 of this segment, and applies comparatively greater restoring force in the radially outward direction against the tissue wall segment. Accordingly, the axial shortening of distal stent segment 22 which 30 accompanies radial expansion, e.g. from a length of 100 mm when delivered to a fixation length of 50 mm, occurs almost entirely by travel of axially inward portion 28, distally or rightwardly as viewed in Figure 4. The slidable engagement of segments 20 and

- 13 -

22 permits such distal travel while proximal segment
20 remains substantially fixed relative to catheter
40.

As sheath 38 is further withdrawn, proximal
5 segment 20 likewise radially expands and axially
shortens. As illustrated in Figure 4, much of
axially outward portion 30 of segment 20 remains
radially compressed within sheath 38, and thus is
held fixed with respect to the catheter.

10 Consequently, the axial contraction of proximal stent
segment 20 during radial expansion occurs almost
entirely by virtue of proximal travel of its axially
inward portion. This of course involves further
sliding of the stent segments relative to one
15 another, and further reduces the axial length of
medial overlapping region 24.

As seen from Figures 2 and 5, the total axial
length of stent 16, designated "L", is substantially
the same whether the stent is in the deployment
20 state, or the radially expanded to equilibrium or
fixation. Proximal stent segment 20 and distal stent
segment 22 are each substantially shorter in
equilibrium. However, virtually all of the reduction
in axial length is reflected in the substantially
25 reduced length of medial overlapping region 24, which
accounts for more than three-fourths of the total
stent length in Figure 2, and only about one-fifth of
the overall stent length in Figure 5.

Eventually, fixation of stent 16 becomes
30 permanent by virtue of the embedding of strands 18
into tissue wall segment 48, and fibrotic growth of
tissue between and around strands to anchor the
stent. This type of fixation occurs over a period of
weeks, and in the intervening time, tissue wall

- 14 -

segment 48 may yield to allow further radial expansion of a stent, and further axial shortening of stent segments 20 and 22. The axial length "L" remains substantially constant nonetheless, as this 5 further axial contraction is again reflected in a further shortening of the medial overlapping region. Axial contraction occurs along the medial region, since flared ends 34 and 36 continue to exert a comparatively greater restoring force against the 10 tissue, thus more securely anchoring the ends as compared to the central portions of the stent. Thus, the overall length of the stent is maintained not only during and immediately after fixation, but in the interim until fibrosis permanently secures the 15 stent.

Figure 6 shows an alternative embodiment stent 52, again with concentric and slidably connected proximal and distal stent segments as indicated at 54 and 56. Axially inward portions of the stent 20 segments overlap to form a medial region 58. Stent 52 has an open mesh or weave construction, formed of helically wound and braided filaments 60.

Stent 52, illustrated in its relaxed or unstressed state, does not include radially outward 25 flares at its opposite ends. In lieu of flared ends, each of stent segments 54 and 56 includes at its axially outward end a plurality of reinforcing strands 62 connected to the braided filaments 60, thus to create respective proximal and distal 30 reinforced end regions 64 and 66. The reinforcing strands 62 can, but need not, be of the same construction as the base filaments. In either event, the reinforcement strands lend further elastic resistance to radial compression, such that a given

- 15 -

elastic radial compression of stent 52 requires a greater force at reinforced end regions 64 and 66 as compared to the force required between these regions.

Stent 52 can be deployed in the manner described

5 above in connection with stent 16. Following proper positioning of the stent within a blood vessel or other body cavity, a surrounding sheath similar to sheath 38 is withdrawn proximally from its surrounding relation with stent 52, allowing the

10 stent to radially self-expand into contact with the tissue forming the cavity. Again, stent 52 is selected to have a nominal diameter (in the relaxed state) greater than the diameter of the body cavity, so that base filaments 60 and reinforcement strands

15 62 engage the tissue before full expansion, and are contained short of full expansion by body tissue, for an equilibrium of the restoring force in the stent and the oppositely directed restoring force in the body tissue. With the stent in equilibrium (as shown

20 in Figure 5 in connection with stent 16), reinforced end regions 64 and 66 may or may not flare slightly radially outward from the remainder of the stent. In either event, the restoring force at the reinforced end regions is greater than the restoring force along

25 the remainder of the stent length. Accordingly, the opposite ends of stent 52 tend to remain secure in their axial positioning relative to the body tissue, with axial contraction occurring as substantial reduction in the length of medial region 58.

30 Figure 7 illustrates yet another approach to preserving the axial length of the stent, in this case, a plurality of fixation hooks 70 at the opposite ends of a stent 72 having a slidably

- 16 -

interconnected and coaxial proximal and distal stent segments 74 and 76. Fixation hooks 70 present some risk of injury and thus are more limited in their application than the fixation alternatives previously 5 discussed. Nonetheless, hooks 70 provide a positive and immediate fixation of stent 72 within a cavity at the opposite stent ends. Subsequent radial expansion and axial contraction of stent segments 74 and 76 serves to reduce the length of a medial region 78, 10 preserving the overall length of the stent.

Figures 8 and 9 illustrate a further embodiment stent or prosthesis 80 including a proximal segment 82, a distal segment 84 and a center segment 86 slidably engaged with the proximal and distal 15 segments. All three segments of prosthesis 80 have the previously described open mesh or weave construction of braided filaments. Stent 80 thus includes two overlapping regions intermediate its proximal and distal ends 88 and 90, namely a proximal 20 intermediate region 92 and a distal intermediate region 94. While center segment 86 is shown with a smaller radius than the other segments for convenience of illustration, all segments preferably have substantially the same radius.

Figure 9 illustrates stent 80 in the relaxed or radially expanded state. Each of segments 82, 84 and 86 has a reduced axial dimension as well as a larger radius. Nonetheless, the axial distance between proximal end 88 and distal end 90 remains about the 25 same, with virtually all of the axial contraction reflected in the substantially reduced axial dimensions of intermediate overlapping regions 92 and 94.

- 17 -

Prosthesis 80 can be deployed in the manner described above in connection with other embodiments. Following the desired positioning of the prosthesis within a blood vessel or other body cavity, a 5 surrounding sheath is withdrawn slidably or folded back from a surrounding relation to the prosthesis, permitting it to radially self-expand into contact with a tissue wall segment forming the cavity (not shown). Of course, the diameter of the cavity should 10 be less than the normal or radially expanded diameter of the prosthesis. Prosthesis 80 does not utilize any special end fixation structure such as the earlier described hooks, reinforced ends or flared ends. Rather, the prosthesis is positioned by virtue 15 of the self-expansion and restoring force of the segments, to maintain their relative positions, particularly during their deployment and release from a sheath or the like, but also after fixation. It should be noted that this approach is suitable for 20 the two-segment stents earlier described, although some type of end fixation means facilitates maintaining a constant axial length of the stent. If desired, a fixation structure can be provided at ends 88 and 90.

25 Figures 10 and 11 illustrate yet another embodiment stent 96 including proximal and distal segments 98 and 100, slidably engaged and overlapping along a medial region 102. A strand or wire 104 runs parallel to stent 96 and is secured at points 106 and 30 108 near proximal and distal ends 110 and 112, respectively. Wire 104 is sufficiently flexible to bend along with stent segments 98 and 100 during delivery of the stent to the point of fixation. Yet the wire is stiff and substantially inextensible in

- 18 -

the axial direction. Consequently wire 104 maintains a constant axial separation of proximal end 110 and distal end 112, whether stent segments 98 and 100 are radially confined as shown in Figure 10 or radially

- 5 expanded as seen in Figure 11. With wire 104 positively determining the total length of stent 96, all of the axial contraction of stent segments 98 and 100 is reflected in the reduction of medial overlapping region 102. While the provision and
- 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 1240 1245 1250 1255 1260 1265 1270 1275 1280 1285 1290 1295 1300 1305 1310 1315 1320 1325 1330 1335 1340 1345 1350 1355 1360 1365 1370 1375 1380 1385 1390 1395 1400 1405 1410 1415 1420 1425 1430 1435 1440 1445 1450 1455 1460 1465 1470 1475 1480 1485 1490 1495 1500 1505 1510 1515 1520 1525 1530 1535 1540 1545 1550 1555 1560 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730 1735 1740 1745 1750 1755 1760 1765 1770 1775 1780 1785 1790 1795 1800 1805 1810 1815 1820 1825 1830 1835 1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115 2120 2125 2130 2135 2140 2145 2150 2155 2160 2165 2170 2175 2180 2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3205 3210 3215 3220 3225 3230 3235 3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 4240 4245 4250 4255 4260 4265 4270 4275 4280 4285 4290 4295 4300 4305 4310 4315 4320 4325 4330 4335 4340 4345 4350 4355 4360 4365 4370 4375 4380 4385 4390 4395 4400 4405 4410 4415 4420 4425 4430 4435 4440 4445 4450 4455 4460 4465 4470 4475 4480 4485 4490 4495 4500 4505 4510 4515 4520 4525 4530 4535 4540 4545 4550 4555 4560 4565 4570 4575 4580 4585 4590 4595 4600 4605 4610 4615 4620 4625 4630 4635 4640 4645 4650 4655 4660 4665 4670 4675 4680 4685 4690 4695 4700 4705 4710 4715 4720 4725 4730 4735 4740 4745 4750 4755 4760 4765 4770 4775 4780 4785 4790 4795 4800 4805 4810 4815 4820 4825 4830 4835 4840 4845 4850 4855 4860 4865 4870 4875 4880 4885 4890 4895 4900 4905 4910 4915 4920 4925 4930 4935 4940 4945 4950 4955 4960 4965 4970 4975 4980 4985 4990 4995 5000 5005 5010 5015 5020 5025 5030 5035 5040 5045 5050 5055 5060 5065 5070 5075 5080 5085 5090 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150 5155 5160 5165 5170 5175 5180 5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 6225 6230 6235 6240 6245 6250 6255 6260 6265 6270 6275 6280 6285 6290 6295 6300 6305 6310 6315 6320 6325 6330 6335 6340 6345 6350 6355 6360 6365 6370 6375 6380 6385 6390 6395 6400 6405 6410 6415 6420 6425 6430 6435 6440 6445 6450 6455 6460 6465 6470 6475 6480 6485 6490 6495 6500 6505 6510 6515 6520 6525 6530 6535 6540 6545 6550 6555 6560 6565 6570 6575 6580 6585 6590 6595 6600 6605 6610 6615 6620 6625 6630 6635 6640 6645 6650 6655 6660 6665 6670 6675 6680 6685 6690 6695 6700 6705 6710 6715 6720 6725 6730 6735 6740 6745 6750 6755 6760 6765 6770 6775 6780 6785 6790 6795 6800 6805 6810 6815 6820 6825 6830 6835 6840 6845 6850 6855 6860 6865 6870 6875 6880 6885 6890 6895 6900 6905 6910 6915 6920 6925 6930 6935 6940 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995 7000 7005 7010 7015 7020 7025 7030 7035 7040 7045 7050 7055 7060 7065 7070 7075 7080 7085 7090 7095 7100 7105 7110 7115 7120 7125 7130 7135 7140 7145 7150 7155 7160 7165 7170 7175 7180 7185 7190 7195 7200 7205 7210 7215 7220 7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 8235 8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915 9920 9925 9930 9935 9940 9945 9950 9955 9960 9965 9970 9975 9980 9985 9990 9995 10000 10005 10010 10015 10020 10025 10030 10035 10040 10045 10050 10055 10060 10065 10070 10075 10080 10085 10090 10095 10100 10105 10110 10115 10120 10125 10130 10135 10140 10145 10150 10155 10160 10165 10170 10175 10180 10185 10190 10195 10200 10205 10210 10215 10220 10225 10230 10235 10240 10245 10250 10255 10260 10265 10270 10275 10280 10285 10290 10295 10300 10305 10310 10315 10320 10325 10330 10335 10340 10345 10350 10355 10360 10365 10370 10375 10380 10385 10390 10395 10400 10405 10410 10415 10420 10425 10430 10435 10440 10445 10450 10455 10460 10465 10470 10475 10480 10485 10490 10495 10500 10505 10510 10515 10520 10525 10530 10535 10540 10545 10550 10555 10560 10565 10570 10575 10580 10585 10590 10595 10600 10605 10610 10615 10620 10625 10630 10635 10640 10645 10650 10655 10660 10665 10670 10675 10680 10685 10690 10695 10700 10705 10710 10715 10720 10725 10730 10735 10740 10745 10750 10755 10760 10765 10770 10775 10780 10785 10790 10795 10800 10805 10810 10815 10820 10825 10830 10835 10840 10845 10850 10855 10860 10865 10870 10875 10880 10885 10890 10895 10900 10905 10910 10915 10920 10925 10930 10935 10940 10945 10950 10955 10960 10965 10970 10975 10980 10985 10990 10995 11000 11005 11010 11015 11020 11025 11030 11035 11040 11045 11050 11055 11060 11065 11070 11075 11080 11085 11090 11095 11100 11105 11110 11115 11120 11125 11130 11135 11140 11145 11150 11155 11160 11165 11170 11175 11180 11185 11190 11195 11200 11205 11210 11215 11220 11225 11230 11235 11240 11245 11250 11255 11260 11265 11270 11275 11280 11285 11290 11295 11300 11305 11310 11315 11320 11325 11330 11335 11340 11345 11350 11355 11360 11365 11370 11375 11380 11385 11390 11395 11400 11405 11410 11415 11420 11425 11430 11435 11440 11445 11450 11455 11460 11465 11470 11475 11480 11485 11490 11495 11500 11505 11510 11515 11520 11525 11530 11535 11540 11545 11550 11555 11560 11565 11570 11575 11580 11585 11590 11595 11600 11605 11610 11615 11620 11625 11630 11635 11640 11645 11650 11655 11660 11665 11670 11675 11680 11685 11690 11695 11700 11705 11710 11715 11720 11725 11730 11735 11740 11745 11750 11755 11760 11765 11770 11775 11780 11785 11790 11795 11800 11805 11810 11815 11820 11825 11830 11835 11840 11845 11850 11855 11860 11865 11870 11875 11880 11885 11890 11895 11900 11905 119

- 19 -

the functional advantages of a helically wound, braided filament design are achieved without the disadvantages associated with axial shortening.

- 20 -

CLAIMS

1. A device for fixation in a body cavity, comprising:
 - a stent (16) including generally tubular
 - 5 and coaxial first and second open weave stent segments (20, 22) slidably engaged along respective first and second axially inward portions overlapping one another to form a medial region (24) of the stent (16), said stent segments (20, 22) further including
 - 10 respective non-overlapping first and second axially outward regions (30, 32) including respective and opposite first and second ends (34, 36) of the stent (16);
 - 15 said stent segments (20, 22), at least along said axially inward portions, having a predetermined first diameter and a predetermined first axial length, said stent segments (20, 22) being radially compressible to a second diameter less than said first diameter and to a second axial length
 - 20 longer than said first axial length, to facilitate an axial insertion of said stent (16) into a body cavity for delivery to a selected location therealong and subsequent fixation of the stent (16) within the cavity by effecting an engagement of the stent
 - 25 segments (20, 22) with a tissue wall segment defining said body cavity; and
 - wherein said first and second axially inward portions slide relative to one another to reduce the axial length of said medial region (24) as
 - 30 said stent segments (20, 22) radially expand into said engagement, thus to maintain a substantially constant axial length of said stent (16) during said radial expansion.

- 21 -

2. The device of Claim 1 wherein:

each of said stent segments (20, 22) is an open weave construction of helically wound filaments (18) of a resilient, body-compatible material.

5 3. The device of Claim 2 further including:

a means for fixing said first and second ends (34, 36) to said tissue wall segment.

4. The device of Claim 3 wherein:

10 said stent segments (20, 22) are flexible and have said predetermined first diameter and first axial length when not subject to external force, and are elastically compressible to said second diameter.

5. The device of Claim 4 wherein:

15 said fixing means comprises first and second flared outer end portions of said first and second axially outward regions (30, 32), respectively, whereby said first and second ends (34, 36) have diameters greater than said first diameter when the stent (16) is in the relaxed state.

20 6. The device of Claim 5 wherein:

the diameters of said first and second ends (34, 36) are greater than said first diameter by at least five percent.

7. The device of Claim 6 wherein:

25 the axial length of each of said flared outer end portions is less than one-third of the axial length of its associated one of said stent segments (20, 22).

8. The device of Claim 4 wherein:

30 said fixing means comprises elastic reinforcing strands connected to said filaments along first and second outer end portions including said first and second ends (34, 36), respectively.

9. The device of Claim 3 wherein:

- 22 -

said fixing means comprises first and second pluralities of fixation hooks mounted to the stent (16) at said first and second ends (34, 36), respectively.

- 5 10. The device of Claim 1 further including:
 an elongate, flexible and substantially inextensible member running axially and connected to said first and second stent segments (20, 22) proximate said first and second ends (34, 36), for maintaining the axial length of the stent (16) constant during said radial expansion.
- 10

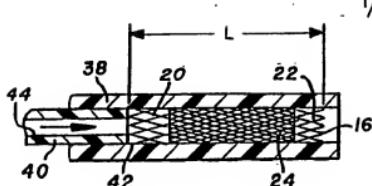


FIG. 2

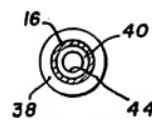


FIG. 3

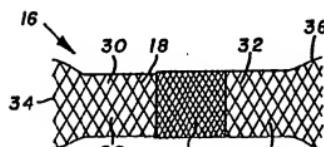


FIG. 1

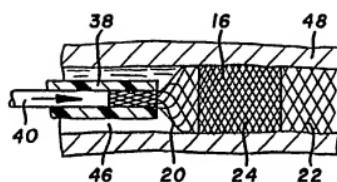


FIG. 4

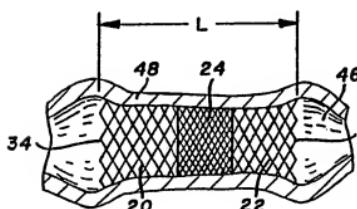


FIG. 5

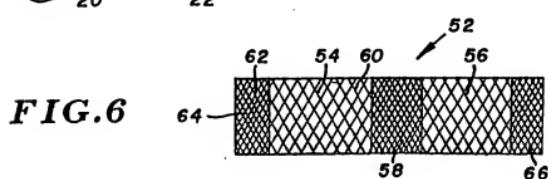


FIG. 6

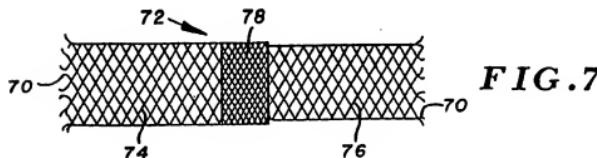
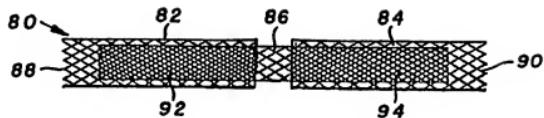
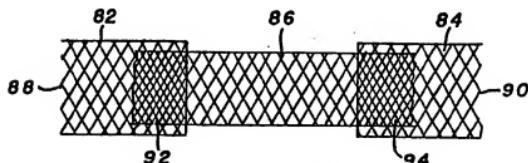
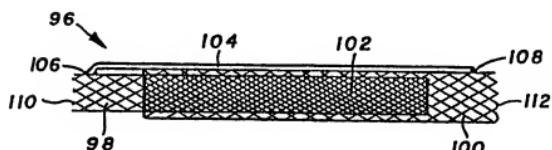
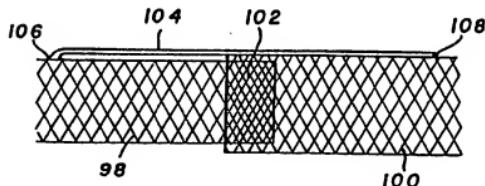


FIG. 7

2/2

**FIG. 8****FIG. 9****FIG. 10****FIG. 11**

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US 91/02854

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)⁶According to International Patent Classification (IPC) or to both National Classification and IPC
Int.C1.5 A 61 F 2/06.

II. FIELDS SEARCHED

Minimum Documentation Searched?

Classification System	Classification Symbols
Int.C1.5	A 61 F
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸	

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category ¹¹	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	EP-A-0 177 330 (COOK INC.) 09 April 1986, see page 5, line 29 - page 6, line 24; figures ---	1-7, 9
Y	GB-A-2 189 150 (MEDINVENT) 21 October 1987, see the abstract; page 3, lines 39-51 ---	1-7, 9
Y	WO-A-8 908 433 (H.M. LAZARUS) 21 September 1989, see page 7, line 24 - page 8, line 24; figure 2 ---	9
A	EP-A-0 183 372 (RAYCHEM) 04 June 1986, see page 7, line 15 - page 8, line 13; page 9, line 24 - page 10, line 21; figures ---	2-8 -/-

* Special categories of cited documents :¹⁰

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "T" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but which may cast doubt on the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search
22-08-1991

Date of Mailing of this International Search Report

08.10.91

International Searching Authority

EUROPEAN PATENT OFFICE

Signature of Authorized Officer



Nuria TORIBIO

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	WO-A-8 300 997 (H.I.WALLSTEN) 31 March 1983, see page 15, lines 3-16; figures 11-13 (cited in the application) ----	10
A	EP-A-0 335 341 (EXPANDABLE GRAFTS) 04 October 1989 ----	
A,P	EP-A-0 421 729 (MEDTRONIC) 10 April 1991, see figure 3 ----	1
A	US-A-3 623 484 (R.R. SCHULTE) 30 November 1971 ----	
A	FR-A-2 409 747 (P.REY et al.) 22 June 1979, see figure 8 ----	1
A	DE-B-1 766 921 (NATIONAL RESEARCH DEVELOPMENT CORPORATION) 15 January 1970, see column 6, lines 55-61; column 7, lines 3-6,12 - column 8, line 2; figures 1,3,6,7 ----	2-6,8,9
A	US-A-4 681 110 (D.M. WIKTOR) 21 July 1987, see column 3, lines 25-38, 49-54; figures (cited in the application) ----	2-4,9

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. US 9102854
SA 47933**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 12/09/91. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A- 0177330	09-04-86	US-A-	4580568	08-04-86
		AU-B-	581464	23-02-89
		AU-A-	4811385	10-04-86
		CA-A-	1245527	29-11-88
		JP-A-	61087540	02-05-86
GB-A- 2189150	21-10-87	SE-B-	453258	25-01-88
		DE-A-	3713384	22-10-87
		FR-A-	2600882	08-01-88
		SE-A-	8601827	22-10-87
WO-A- 8908433	21-09-89	AU-A-	3439289	05-10-89
		EP-A-	0407425	16-01-91
EP-A- 0183372	04-06-86	JP-A-	61098254	16-05-86
WO-A- 8300997	31-03-83	AT-B-	392733	27-05-91
		AU-A-	8954282	08-04-83
		CA-A-	1204643	20-05-86
		CH-A-	.657521	15-09-86
		DE-T-	3249027	31-10-84
		EP-A-	0088118	14-09-83
		FR-A,B	2512678	18-03-83
		GB-A,B	2124908	29-02-84
		JP-T-	58501458	01-09-83
		NL-T-	8220336	02-01-84
		SE-B-	444761	12-05-86
		US-A-	4553545	19-11-85
EP-A- 0335341	04-10-89	AU-A-	3174289	28-09-89
		JP-A-	1299550	04-12-89
EP-A- 0421729	10-04-91	JP-A-	3151983	28-06-91
US-A- 3623484	30-11-71	US-A-	3738365	12-06-73
FR-A- 2409747	22-06-79	DE-A,C	2851010	31-05-79
		GB-A,B	2011260	11-07-79
		JP-C-	1390311	23-07-87

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. US 9102854
SA 47933

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 12/09/91. The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
FR-A- 2409747		JP-A-	54085597	07-07-79
		JP-B-	61059730	17-12-86
		US-A-	4225979	07-10-80
DE-B- 1766921	15-01-70	None		
US-A- 4681110	21-07-87	None		

EPO FORM 1009

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- BLACK BORDERS**
- IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- FADED TEXT OR DRAWING**
- BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- SKEWED/SLANTED IMAGES**
- COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- GRAY SCALE DOCUMENTS**
- LINES OR MARKS ON ORIGINAL DOCUMENT**
- REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.